National Aeronautics and Space Administration

Goddard Earth Science Data Information and Services Center (GES DISC)

README Document for OCO-2 GEOS L3 XCO2 Products

Last Revised 3/28/2022

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Revision History

Revision Date	***Changes***	***Author***
3/22/2022	Document Created	Kristan Morgan
3/24/2022	Edits to section 4	Kristan Morgan
3/28/2022	Edits to section 3	Kristan Morgan

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1 Introduction

This README file attempts to address basic most important information on the NASA's Orbiting Carbon Observatory 2 Goddard Earth Observing System (GEOS) Level 3 (L3) gridded, gap-filled, column-averaged, dry-air mole fraction of carbon dioxide (XCO_2) products. These fields are produced by assimilating OCO-2 retrievals into GEOS with the Constituent Data Assimilation System (CoDAS). Data are provided globally at 0.5° x 0.625° resolution at both daily and monthly frequencies from 1 January 2015 to present, typically with a two to three-month latency.

OCO-related documentation, including the new OCO-2 and OCO-3 User Guide and the Data Quality Statement, are posted on the OCO product page:
https://disc.gsfc.nasa.gov/information/documents?title=OCO-2 Documents

Brief overview of OCO-2 mission, retrieval concept, description of the content of the current and planned for public distribution OCO-2 data products, naming conventions, key data fields recommendations for data analysis, and tools to view and search the data products are all provided in the current User Guide from the above Documents link.

OCO-2 employs a dedicated spacecraft with a single instrument. It was launched on July 2, 2014, into a near-polar orbit on an expendable launch vehicle. OCO-2 joined the A-Train formation of satellites on August 3, 2014. The OCO-2 instrument incorporates three high-resolution spectrometers that make coincident measurements of reflected sunlight in the near-infrared CO2 near 1.61 and 2.06 μm, and in molecular oxygen (O2) A-Band at 0.76 μm.
Concerning the spectral domain, high spectral resolving power ($\lambda/\delta\lambda > 20{,}000$) is needed to resolve the CO2 and O2 lines from the adjacent continuum to maximize the sensitivity to small (< 0.3%) variations in total column CO2.

In the spatial domain, the OCO-2 instrument have a narrow swath - it collects 8 soundings over its 0.8-degree wide swath every 0.333 seconds, yielding surface footprints with along-track dimensions < 2.25 km and cross-track dimensions that vary from 0.1 to 1.3 km at nadir.

1.1 Product Description

The full suite of the OCO-2 L3 products is given in Table 1. These are all data collections currently released by the OCO-2 Science Team.

Table 1

Product	Long Name	Level	Version
OCO2_GEOS_L3CO2_MONTH_10r	OCO-2 GEOS Level 3 monthly, 0.5x0.625 assimilated CO2 V10r (OCO2_GEOS_L3CO2_MONTH) at GES DISC	3	10r

OCO2_GEOS_L3CO2_DAY_10r	OCO-2 GEOS Level 3 daily, 0.5x0.625 assimilated CO2 V10r (OCO2_GEOS_L3CO2_DAY) at GES DISC	3	10r

2 Data Description

2.1 Naming Conventions and Format

The standard full name for OCO GEOS L3 products will follow the format described below: [**satellite**]_[**data product**]_[**time resolution**]_[**date**]_[**build ID**]Ar.nc4

For all files, **satellite** = 'oco2' and **data product** = 'GEOS_L3CO2'. **Time resolution** describes the frequency at which variables are written within the file and can be 'month' or 'day'. **Date** defines the day or month contained in the file and has the form yyyymm for monthly files, and the form yyyymmdd for daily files. More details on filenames are given in the description of available datasets below. Note that the OCO L2 products use a 2-digit year while we use a 4-digit year identifier.

2.2 Science Area

NASA successfully launched its first spacecraft dedicated to studying atmospheric carbon dioxide at 2:56 a.m. PDT (5:56 a.m. PDT) on Wednesday, July 2, 2014. Orbiting Carbon Observatory-2 (OCO-2) is NASA's first dedicated Earth remote sensing satellite to study atmospheric carbon dioxide from space. OCO-2 is an exploratory science mission designed to collect space-based global measurements of atmospheric CO_2 with the precision, resolution, and coverage needed to characterize sources and sinks (fluxes) on regional scales (≥1000km). OCO-2 will also be able to quantify CO_2 variability over the seasonal cycles year after year. This mission will also validate a space-based measurement approach and analysis concept that could be used for future systematic CO_2 monitoring missions.

3 Data Contents

3.1 Available Data

Data are provided in netCDF format in the following collections:

oco2_GEOS_L3CO2_day: OCO-2 Level 3 Daily XCO2

Frequency: *Daily, containing 1 daily value*
Dimensions: *longitude=576, latitude=361, time=1*
Granule Size: *~3.2 MB*
Short name: *oco2_GEOS_L3CO2_day*

Filename: *oco2_GEOS_L3CO2_day_**yyyymmdd**_B10206Ar.nc4 where **yyyymmdd** reflects the 4-digit year, month, and day of the date whose contents are reported in the file.*

doi: 10.5067/Y9M4NM9MPCGH

Science Variables

Name	***Dim***	***Description***	***Units***
XCO2	tyx	CO2 Dry-Air Column Average (analysis)	mol mol-1
XCO2PREC	tyx	CO2 Dry-Air Column Average Precision	mol mol-1

oco2_GEOS_L3CO2_month: OCO-2 Level 3 Monthly XCO2

Frequency: *Monthly, containing 1 monthly value*

Dimensions: *longitude=576, latitude=361, time=1*

Granule Size: *~3.2 MB*

Short name: *oco2_GEOS_L3CO2_month*

Filename: *oco2_GEOS_L3CO2_month_**yyyymm**_B10206Ar.nc4 where **yyyymm** reflects the 4 digit year and month whose contents are reported in the file.*

doi: 10.5067/BGFIODET3HZ8

Science Variables

Name	***Dim***	***Description***	***Units***
XCO2	tyx	CO2 Dry-Air Column Average (analysis)	mol mol-1
XCO2PREC	tyx	CO2 Dry-Air Column Average Precision	mol mol-1

4 Data Services

4.1 Goddard DAAC Unified Interface

The Goddard DAAC transitioned to a content-based web interface. All content, including the datasets, is searchable by appropriate keywords. For example, a good way to search and find the information pages on all available OCO-2 products is:

https://disc.gsfc.nasa.gov/datasets?keywords=oco-2&page=1

The search should produce links to product landing pages, from where all additional information on data access methods and documentation can be found.

4.2 Tools for reading data

4.2.1 Brief Code Recipes

The best source of code recipes, including for reading of the OCO data files, in different programming languages is given in the "HDF Zoo".

4.2.2 ncdump

Unidata's NetCDF-C is a downloadable set of software libraries. Included is ncdump, a command line utility to read netCDF4 files and their contents in text form.

To read the entire file contents: ncdump filename.nc4

To read only the header information: ncdump -h filename.nc4

To read a data subset of select variable(s): ncdump -v latitude,longitude filename.nc4

4.2.3 Panoply

Panoply is a cross-platform data viewer software that is compatible across Mac, Windows and Linux machines that is commonly used to plot geo-referenced arrays from netCDF, HDF and GRIB data files.

Information about Panoply's capabilities: https://www.giss.nasa.gov/tools/panoply/
Instructions for downloading Panoply: https://www.giss.nasa.gov/tools/panoply/download/

FAQ's with instructions on how to use Panoply exist at:
https://disc.gsfc.nasa.gov/information/howto?keywords=panoply&page=1

And particularly useful is the usage of "remote catalogs" in Panoply that allows data to be viewed without downloading, through OPeNDAP catalogs:
https://disc.gsfc.nasa.gov/information/howto?keywords=panoply&title=How%20to%20View%20Remote%20Data%20in%20OPeNDAP%20with%20Panoply

4.3 On-line access

Note that authenticated data access has been mandated in 2016. Instruction for registration and data download strategies are provided here:
https://disc.gsfc.nasa.gov/data-access
Since all data are on-line, users can do global recursive downloads using "wget" or "curl" command-line utilities . The top data directory for OCO-2 where the gridded datasets are located is:
https://oco2.gesdisc.eosdis.nasa.gov/data/OCO2_DATA/

4.4 OPeNDAP

OPeNDAP stands for “Open-source Project for a Network Data Access Protocol”. OPeNDAP is a framework that simplifies all aspects of scientific data networking. It provides simple means for parameter and spatial subset. In the case of OCO-2 Level 1 and 2 data, the simple spatial subset can be materialized by array indexes, not geographical coordinates. In the most simplistic case, OPeNDAP can be used to convert data from HDF5 to NetCDF3, ASCII, and plain binary. The data directory hierarchy, as served by OPeNDAP, can be viewed in any browser:
https://oco2.gesdisc.eosdis.nasa.gov/opendap/
In this case OPeNDAP will be convenient to preview file contents and in particular variables names, dimensions sizes, and quick print of reasonably small variables to the screen.

4.4.1 wget

Examples for downloading remote datasets with wget with the user’s GESDISC Earthdata account are provided below. Please visit the windows wget summary and mac/linux wget summary for more information.

wget for Windows

Downloading one file:

wget --load-cookies C:\.urs_cookies --save-cookies C:\.urs_cookies --auth-no-challenge=on --keep-session-cookies --user=<your username> --ask-password <url>

Downloading multiple files:

wget --load-cookies C:\.urs_cookies --save-cookies C:\.urs_cookies --auth-no-challenge=on --keep-session-cookies --user=<your username> --ask-password -i <url.txt>

wget for Mac/Linux

Downloading one file:

curl -n -c ~/.urs_cookies -b ~/.urs_cookies -LJO --url <url>

Downloading multiple files:

cat <url.txt> | tr -d '\r' | xargs -n 1 curl -LJO -n -c ~/.urs_cookies -b ~/.urs_cookies

4.5 Summary Access

To summarize, the new Goddard DAAC interface allows to search and find information by content, like “dataset”, “project”, “data release”, etc. For instance, all datasets currently publicly available from the OCO project can be found using:

https://disc.gsfc.nasa.gov/datasets?keywords=oco&page=1&project=OCO-2

5 More Information

- Product User Guide can be found here: User Guide

- Detailed Science Team documentation on all OCO-2 products can be found at:

https://disc.gsfc.nasa.gov/information/documents?title=OCO-2 Documents

- GES DISC is also summarizing essential information for every OCO-2 product in product pages that can be accessed from:

https://disc.gsfc.nasa.gov/datasets?project=OCO

- OCO-2 Science Team at JPL is maintaining an excellent website, where the richest information, from the sensor/spacecraft operations, to science perspectives of CO2 observations, can be found:

http://oco.jpl.nasa.gov/

For further assistance, please use this contact information:

Email: gsfc-dl-help-disc at mail.nasa.gov

Voice: 301-614-5224

Fax: 301-614-5268

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6 Acknowledgments

This work has been supported by NASA's Carbon Monitoring System Program: NNH20ZDA001N-CMS (20-CMS20-0011), NNH16DA001N (16-CMS16-0054). and NNH14ZDA001N (14-CMS14-0032), and OCO Science Team: NNH17ZDA001N-OCO2 (17-OCO2-17-0010).

Please, cite the data as indicated:

Lesley Ott, Brad Weir, OCO-2 GEOS Level 3 daily, 0.5x0.625 assimilated CO2 V10r, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], doi: 10.5067/Y9M4NM9MPCGH

Lesley Ott, Brad Weir, OCO-2 GEOS Level 3 monthly, 0.5x0.625 assimilated CO2 V10r, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], doi: 10.5067/BGFIODET3HZ8

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